29 September 2008

The Honorable Leon R. Sequeira
Assistant Secretary for Policy
U.S. Department of Labor
200 Constitution Avenue, NW, S-2312
Washington, DC 20210

RIN 1290-AA23: "Requirements for DOL Agencies' Assessment of Occupational Health"

Dear Mr. Seguiera,

As experts in the field of risk analysis, we were intrigued to read about this Notice of Proposed Rulemaking (NPRM) that would prescribe rules for the performance of risk assessment by Department of Labor agencies, chiefly the Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA).[1] We are providing these public comments in the public interest to assist you as you strive to finalize this regulation.

Regulatory Checkbook is a 501(c)(3) nonprofit organization whose mission is to improve the quality of science and economics used in regulatory decision-making. We do not take sides on substantive regulatory issues, nor do we lobby. Although Regulatory Checkbook has taken the initiative to organize this letter, the opinions expressed are those of the signatories, who share a common bond and passion for quality risk assessment and well-informed decision-making.

Our comments are divided up into several sections. First, we address specific procedural issues on which the Department has sought input. Second, we offer advice on the overarching question of whether, and if so, how to establish a set of principles for risk assessment that balances the competing desires for consistency and predictability on the one hand, with flexibility for innovation on the other. Third, we offer suggested improvements in the Department's proposed definitions. Without clear language, your effort seems likely

[1] See U.S. Department of Labor (2008a, hereinafter "NPRM").

PO Box 319
Mount Vernon, VA 22121
(703) 780-1850

to falter. Finally, we offer a few suggested risk assessment principles that we believe are important enough to codify in a rule but not so burdensome that they would in any way constrain good risk assessment practice. In fact, we believe that codifying these principles would create desirable incentives for scientific advancement and innovation in risk assessment methodology.

PROCEDURAL MATTERS

The Department specifically requested comment on the proposed requirement for an Advanced Notice (ANPRM) stage and for DOL agencies to adhere to newly established e-government requirements.

1. **The proposed ANPRM stage is welcome and can be implemented without causing delay.**

The proposed ANPRM stage appears to mimic what the U.S. Environmental Protection Agency (EPA) does when it issues a "data call-in." There should be nothing controversial about this, as DOL agencies embarking on risk assessments can only be aided by inviting public input early in the process. EPA also has a planning step in which it lays out for public review how it intends to go about the risk assessment process, and we believe DOL agencies should mimic this process as well.

There is one feature of the Department's proposal with which we strongly disagree: the notion that ANPRM and NPRM stages can run concurrently:

> The Department expects that the publication of the ANPRM, collection of public comments, and review will occur simultaneously with the ordinary development of the standard in order to ensure that the rulemaking process is not delayed or slowed.[2]

We agree that the ANPRM step should not delay the completion of risk assessment or rulemaking, but it would be a mistake to run the ANPRM data call-in process at the same time that the risk assessment and NPRM are being developed. The purpose of the ANPRM data call-in is to inform and guide risk assessment, and minimize conflicts over data, models and the like. A successful ANPRM process will expedite,

[2] (U.S. Department of Labor 2008a, p. 50914, emphasis added).

not delay, the completion of risk assessment. The earlier that the important technical issues are raised and resolved, the better.

2. Full and early public disclosure of all relevant data, models, documentation and analyses is essential.

The federal government's regulatory document portal is a big improvement over the "old days" when interested parties had to travel in person to government offices to inspect the docket. It is, however, painstaking to use. In large dockets (which would be likely for major DOL agency risk assessments), it can be very difficult to locate documents without knowing the Document ID Number. The system allows for the use of keyword searches, but the utility of these searches depends on whether agency staff input useful keywords. (Commenters are not allowed to provide their own keywords – a critical design defect.)

We do not expect the Department to remedy problems with regulations.gov. However, we do hope that the Department will implement electronic docketing requirements in a way that takes account of its limitations. Toward that end, it would be very helpful if the Department ensured that DOL agency personnel responsible for maintaining the dockets receive the highest level of training and their performance was evaluated solely based on customer service feedback.

The specific time schedule set forth in the NPRM ("fourteen days after the conclusion of the relevant step in the rulemaking process," p. 50915) is fine in cases where the public comment period is a long one, but it not appropriate in case where the public comment periods is short. We recommend that the clock start on public comment once the last relevant document has been uploaded to regulations.gov.[3] No part of the public comment period should be consumed by agency delay in making information public.

[3] This can be easily implemented at least two ways, which are not mutually exclusive: (1) require that all documents be uploaded before publication in the *Federal Register*, or (b) establish an automatic right to an extension of the public comment period upon request where the basis of the request is late docketing of relevant information.

PRINCIPLES FOR WRITING PRINCIPLES FOR RISK ASSESSMENT

The principles and practices of risk assessment have developed over several decades. We have either participated personally in or observed up close several well-intentioned efforts to provide needed order and structure to the risk assessment process. It is based on that personal experience that we offer advice regarding how to approach this complex task.

1. Resist the temptation to do too much.

The field of risk analysis is extraordinarily broad and complex. Previous attempts to rationalize risk assessment have fallen prey to the honest desire to be comprehensive. This desire is admirable but almost certainly destined to be unsatisfying. Your chances for success are significantly improved if you resist calls to expand the scope of the rule beyond the assessment for occupational health risks.

We are aware that a draft version of the NPRM was circulated before the NPRM was published (U.S. Department of Labor 2008). There are several places in that text where the Department appears to have tried to reach beyond risk assessment – in particular, into *risk communication* and *feasibility analysis*. No doubt, there will be public commenters asking you to restore these provisions. We urge you to resist those calls.

Risk communication at its most fundamental level is already covered by the Department's Information Quality Guidelines (IQG) (U.S. Department of Labor 2002). Adherence with these guidelines in the practice of risk assessment generally will achieve most of what an explicit expansion into risk communication would accomplish. The key information quality principles that affect risk communication are *transparency*, *reproducibility*, and *presentational objectivity*. Adhering to these principles throughout the risk assessment process will enable you to achieve most of your risk communication goals.

2. Emphasize performance standards, not design standards.

It is an axiom of regulatory policy that performance standards are generally preferred to design standards (Breyer 1982; Viscusi et

al. 1997; White 1981).[4] When OSHA and MSHA regulate, performance standards encourage innovation and creativity, and avoid the inefficiencies that accompany one-size-fits-all constraints that fail to take account of heterogeneity in the workplace. Performance standards allow regulated parties to devise their own solutions so long as they achieve the standard.

Breyer and others were writing from an economics perspective and at a time when the science of risk assessment was still young. Nevertheless, the same lessons apply to rules government the performance of risk assessment. The Department could prescribe that its agencies use very explicit, detailed techniques, or that it use the same methods that it has used in the past in the name of consistency.[5] Unfortunately, the imposition by rule of such design standards freezes risk assessment technology and unwittingly encourages a "cookbook" or "checklist" mentality among risk assessors and the agency lawyers whose job it is to protect them from legal challenge. This discourages innovative research in toxicology, epidemiology, exposure assessment, and decision analysis. Performance standards, however, create the intellectual space for scientific innovation. They also offer the potential for rewarding regulated entities and third parties for collecting data that OSHA and MSHA need to plug data gaps and make their risk assessments better.[6]

---

[4] Viscusi et al. (pp. 825-826) specifically advocate performance standards for OSHA: "The use of performance standards rather than narrowly defined specification standards could … enable firms to select the cheapest means of achieving the health and safety objective." In their view, occupational *safety* is much more readily addressed by market forces through compensating wage premiums, whereas "the coupling of substantial uncertainties with low probability events involving potentially catastrophic outcomes makes health risks a promising target for government regulation."

[5] See p. 50910: "This proposed regulation compiles in one easy-to reference regulation, all of the Department's existing best practices related to risk assessment…"

[6] This potential can be realized only if the Department establishes an enforceable principle that DOL agencies must utilize better science and methods as they become available.

The recent National Research Council review of the Office of Management and Budget's proposed risk assessment guidance identified a number of areas in which committee members believed that the draft was overly prescriptive.[7] In several cases, excess prescriptiveness was the result of specific risk assessment technology requirements embedded in the text or preamble. The committee advised OMB to promulgate broad principles for risk assessment but allow the agencies the flexibility to achieve these principles in a variety of ways. That is the essence of regulation by performance standards.

In general, the rule text in the NPRM appears to be oriented toward performance standards that would permit and reward scientific advancement and technical innovation in risk assessment. However, this orientation is compromised by conflicting text in the preamble that elevates *consistency* and *reliability* as goals for DOL agency risk assessors to achieve. As we indicate in the following section, the goals of *consistency* and *reliability* are incompatible with scientific and technical advancement. They push in exactly the opposite direction – toward tradition, convention, and the status quo.

3. **Make mandatory the adherence to reasonable minimum performance standards, but make all other provisions suggestive.**

The rule text and especially the preamble display some confusion about which provisions are mandatory. This confusion is most evident in the choice of instructions that are directive (e.g., "shall," "must," "will) or suggestive (e.g., "should"). We believe that provisions need to be mandatory to be assured of being effective, but at the same time, the Department ought not be overly prescriptive where variation and innovation are desirable. By using performance standards instead of design standards, the Department can be much more comfortable about making certain provisions mandatory without fear of inhibiting scientific advancement and innovation in risk assessment methods. Indeed, mandatory performance standards can stimulate scientific advancement and innovation in risk assessment.

To be concrete, the goal of objectivity in risk assessment must be mandatory in order for it to be possible for DOL agency risk

[7] See National Research Council (2007, pp. 13-16).

assessments to consistently adhere to the Information Quality Act and the Department's implementing guidelines (U.S. Department of Labor 2002). That does not mean DOL agencies should have to prove that their risk assessments are objective. The Department's Information Quality Guidelines prescribe a system in which its agencies obtain a rebuttable presumption of objectivity if they rely on scientific information that has been adequately peer reviewed.[8] The burden rests on an affected person[9] to refute this hypothesis. The question that the Department needs to address is how strong an evidentiary showing is sufficient to make a "persuasive showing." For example:

- Is it sufficient for an affected person to show that the peer review on which the agency relies did not address objectivity in its review? It is hard to credibly argue that peer review should confer a presumption of information quality objectivity if the reviewers did take account of information quality principles in their review.
- Is it sufficient for an affected person to show that alternative data or models are higher quality (including *more* objective) than the data or models that otherwise would be used? DOL agencies should not demand perfection as the price for displacing existing assumptions, data or models, nor should they impose higher quality standards on scientific information obtained from third parties than they impose on themselves.

The National Research Council committee that reviewed OMB's proposed risk assessment guidance recognized these problems and called for a clear distinction between the roles of agency risk assessors and risk managers:

[8] U.S. Department of Labor (2002, p. 12): "If data and analytic results have been subjected to formal, independent, external peer review, the information may generally be presumed to be of acceptable objectivity. However, this presumption is rebuttable based on a persuasive showing by the petitioner in a particular instance."

[9] "Affected person" is the term of art used to define those who utilize the Department's administrative process for error correction. See U.S. Department of Labor (U.S. Department of Labor 2002, p. 9).

> Alternative models and assumptions based on new scientific data will, like the defaults they may replace, always have some degree of scientific uncertainty. In considering such alternatives, agency risk assessors should not be placed in the position of having to decide "how much evidence is sufficient" to adopt the alternative. Rather, they should attempt to describe the scientific bases of a proposed alternative and describe how certain it is. Deciding whether it is "sufficiently certain" to replace a default or is to be given more weight, equal weight, or less weight than the default may be seen as requiring a combination of scientific and policy considerations that go beyond risk assessment. With this approach, risk assessors do not discard alternative models and assumptions unless they clearly lack substantial scientific merit; rather, they attempt to judge and describe the relative scientific merits.[10]

Given that the NRC committee encouraged OMB to recast its guidance along these lines, the Department is surely well within the scope of external scientific advice to do so as well.

3. Use established definitions for risk terms and concepts whenever possible.

The risk assessment community is quite diverse, and we have struggled for decades to coalesce around a common language. We have not achieved perfection in that regard, of course, but nevertheless we have accomplished a great deal. This means that when risk assessment practitioners use certain terms, our colleagues in the profession automatically understand what we mean.

The Department's NPRM respects this history to some extent, but on several crucial margins it departs from the accepted lexicon. This is a recipe for confusion at best, and failure at worst. Risk assessors must implement this rule, so it is vital that you speak our language unless there is a compelling reason otherwise. It would be best if the Department used definitions that already have been established by recognized external authorities, and modified them only as necessary to account for the idiosyncrasies of occupational health. (We offer several alternative definitions below.)

[10] National Research Council (2007, p. 14, emphasis added).

4. Be careful about borrowing risk assessment language, principles and practices from areas that may be incompatible with occupational health.

Because risk assessment covers such a broad range of fields and applications, somewhat different concepts and traditions have developed. Sometimes these concepts and traditions are useful for informing the analysis of problems far afield from where they were developed. In other cases, however, their utility is minimal or even counterproductive. It might seem obvious, for example, that certain risk assessment principles and practices that NASA uses to manage space flight are not readily applicable to occupational health. It might be less obvious, however, that certain principles and practices in ecological risk assessment translate poorly to occupational health settings.

In several places the NPRM seems to have borrowed concepts that do not clearly apply to occupational health.[11] "Events" can be hazards, of course, but they would appear to lie beyond the domain of occupational health.

DEFINITIONS

Several important risk analysis terms must be defined, most of which are relegated to the preamble. We strongly urge the Department to include all relevant terminology in the rule text and use the preamble only for explaining the text. Below, we present a list of risk analysis terms that we believe require explicit definition, and we offer suggested language from established external sources.

[11] See the inclusion of "event" in the definition of *hazard*, reprinted in footnote 2.

1. Hazard.

DOL NPRM	Suggested Alternative
A "hazard" is an intrinsic property of a substance or event, which has the potential to cause harm.	An "occupational health hazard" is an agent that has a positive probability of causing an adverse human health effect at occupational exposure levels.

We have several concerns about the Department's proposed language. First, it is conventional practice in risk assessment to use the term "agents" rather than "substances" to ensure that the definition is not restricted to chemicals. Radiation and pathogens, for example, ought to be included within the scope of occupational hazards. We make this change throughout our comments and recommended changes.

Second, there is a long history in which *hazard* is described as an "intrinsic" property of an agent.[12] Scientific knowledge has grown over the years, however, and it is increasingly clear that hazard is not an intrinsic property. We now know of many chemicals that are hazardous or toxic at high does but beneficial or event essential at low doses. Examples include a number of metals that are toxic at high doses, but are, in fact, essential for good health; selenium, chromium, and copper are prominent examples. The presence of trace amounts of these elements is critical for survival, and thus they are known as "essential micronutrients." At much greater doses, however, these elements can be toxic or even lethal. Even oxygen, without which life would be completely impossible, can present a serious threat at high concentrations for prolonged periods. It is untenable to say that *hazard* is not an intrinsic property of oxygen, nor is it useful to classify oxygen as a *hazard* irrespective of exposure or dose. If agents must

[12] See Faustman and Omenn (2001, p. 84): "The term *hazard* is used in the United States and Canada to refer to intrinsic toxic properties, whereas internationally this term is defined as the probability of an adverse outcome." The fact that North America and Europe define the same term in contrary ways reinforces the need for the Department to ensure clarity in its terminology.

be classified, the range of exposures or doses that could occur in occupational settings should govern classification decisions.[13]

The fundamental principle of toxicology is that "the dose makes the poison."[14] For that reason, we suggest limiting the scope of the definition to exclude exposure levels that are implausible in the workplace. Otherwise, there exists a serious potential for DOL agencies to be distracted by hypothetical circumstances and scenarios. We also recommend deleting "events" because that strays beyond occupational health and into occupational safety. Our proposed alternative language is slightly modified from the National Research Council's *Science and Judgment* report.[15]

Third, we recommend against using the term *harm* and using the more conventionally used term *adverse health effect*. The adjective *adverse* makes clear that health effects need not always be undesirable; it is health effects that are "adverse" that attract our attention. The risk assessment community has struggled to develop objective measures of adversity; we address that below in our suggestion that the Department explicitly define "adversity." There is a consensus within the scientific community, however, that "adverse effects may be manifest along a continuum" (National Research Council 2007, p. 3), so it is essential to avoid treating adversity as an either-or proposition and to affirmatively account for the characteristics of adversity that crucially affect the description of a risk. Most notable among characteristics are severity (how "bad" it is from the perspective of those who experience it) and reversibility (for how long it is "bad").

---

[13] An unintended consequence of the notion that *hazard* is an intrinsic property is the propensity of government agencies to create lists of agents that are *hazardous, toxic*, or *carcinogenic*, without regard for the minimum dose necessary to make the characteristic true. This short-circuits risk assessment and leads to serious resource misallocation in risk management decision-making.

[14] This principle is attributed to Paracelsus: "All substances are poisons; there is none which is not a poison. The right dose differentiates a poison from a remedy." See Klaassen (2001, p. 4).

[15] See National Research Council (1994, p. 4).

Fourth, DOL agencies should focus on adverse health effects that occur as the result of human exposures within the plausible scope of workplace experience. For that reason, we suggest adding the phrase "at occupational exposure levels" at the end of the definition of *hazard*.

Elsewhere, the NPRM uses the terms "significant risk" and "material impairment" in places we would have expected to see *hazard* or *adverse health effect*. We strongly encourage the Department to refrain from using these terms because they are legal terms of art, not scientific constructs. Scientists and risk assessors should not be deciding on behalf of Department decision-makers whether a particular health effect is "adverse enough" to be "significant" or "material." Risk assessors should be informing decision-makers about the nature, severity, reversibility, and practical consequences of experiencing adverse health effects, and stopping at that point.[16]

2. Adversity.

DOL NPRM	Suggested Alternative
[None]	"Adversity" is the nature, severity and reversibility of a negative human health effect.

In decades past, risk assessment tended to make certain default assumptions about what kinds of effects were "adverse." In the early days this was simple in large part because risk assessment was directed toward cancer and frank illness. This notion is captured in multiple National Research Council Reports in which the term "adverse" is routinely used but not clearly defined (National Research Council 1983, 1994).

Adversity clearly depends on the severity of the effect and the extent to which it is reversible. Severe effects are more important tan minor ones; irreversible effects are more important than reversible ones. Adding a definition for *adversity* enables DOL to focus its risk assessment and risk management resources on health effects of greatest concern to workers.

[16] See the comments of the National Research Council reprinted on page 8.

More recently, it has become much less clear what human health effects deserve to be described as "adverse." Some recent risk assessments deal with *precursors* of adverse effects, and while there are circumstances in which this may be necessary,[17] it raises a host of concerns that to date have not been addressed by the risk assessment community.[18] It is essential that DOL agencies be fully transparent, and an explicit definition for *adverse* provides the flexibility to use precursors where it is scientifically justified but holds the line against the temptation to drain the term of meaning.

The NPRM restates the Department's statutory authority to promulgate health standards only upon a finding of "significant risk." (p. 50914). As we indicated earlier, DOL agency risk assessors cannot determine whether a risk is "significant" because "significance" is not a scientific construct and is inherently subjective. Risk assessors can describe the attributes and consequences of a risk so that Department decision-makers are objectively informed before they choose among alternatives. Thus, it really does not matter whether DOL agency risk assessors focus on *adverse* or *nonadverse* effects so long as they do not mischaracterize them.[19]

---

[17] For example, the adverse effect of interest might not be measurable, or it might be so extraordinarily severe that zero incidence is optimal; or it might be an inevitable and quick consequence if the precursor event occurs.

[18] For example, all precursors are not equally important; some cannot be discerned by subjects to even have occurred; some are reversible; some are very distant in exposure or dose from the adverse effect of interest; and some occur because of many other conditions and circumstances such that a causal nexus is difficult or impossible to make. The National Research Council report on the draft OMB risk assessment bulletin took the position that risk assessment should not be limited to adverse effects, but the panel did not address these important issues (National Research Council 2007, pp. 34-37).

[19] A core information quality principle is *presentational objectivity*, which is violated when an agency mischaracterizes information. See U.S. Department of Labor (2002, p. 12): "`Objectivity' includes whether disseminated information is being presented in an accurate, clear, complete, and unbiased manner. This involves whether the information is presented within a proper context. Sometimes, in disseminating certain types of

We do believe, however, that the Department should demand much more information from DOL agency risk assessors when they choose nonadverse effects to estimate. The Department should include language in the rule requiring DOL agency risk assessments based on nonadverse effects to include extensive information scientifically justifying the decision to analyze a nonadverse effect. In addition, it is essential that risk assessors using nonadverse effects as the foundation for risk assessment perform a rigorous probabilistic analysis showing the likelihood that adverse health effects will occur. Otherwise, risk assessments based on nonadverse effects will have no utility for DOL decision-makers.

3. Exposure.

DOL NPRM	Suggested Alternative
Exposure assessment. The exposure assessment step estimates exposure to the hazardous substance in the workplace.	"Occupational exposure assessment" is the estimation of the timing, intensity, frequency, and duration of human occupational contact to an agent, taking account of the identity and characteristics of the occupational population of interest [and physiologically-based pharmacokinetics].

The Department's proposed language is circular and vague. Definitions of critical terms should not include the term being defined within the definition. Our suggested alternative definition, which is modified from the National Research Council's *Science and Judgment* report,[20] captures the several aspects of human contact that we care about: when (timing), to whom (characteristics of the population of concern, such as susceptibility), how much (intensity), how often (frequency), and how long (duration). This information is essential for

information to the public, other information must also be disseminated in order to ensure an accurate, clear, complete, and unbiased presentation."

[20] See National Research Council (1994, p. 5).

understanding the actual conditions of exposure and informing dose-response assessment.

It is important to understand that "exposure" is not the same thing as "dose." Dose-response assessment includes the often-difficult job of converting exposure into dose, which is often defined as the quantity "administered" to the person or "delivered" to the exact site of toxic action or effect. This distinction is crucial because for many agents, exposure through one pathway (e.g., inhalation) has very different consequences than exposure through another pathway (e.g., ingestion).

Typically, *exposure assessment* refers to measuring and/or modeling the release of an agent (such as from an occupational source), followed by its fate, transport, deposition and degradation or retention. We believe that one can legitimately extend the domain of "exposure assessment" to include corresponding physico-chemical processes in the human body. Taken as a class, the latter processes are often referred to as physiologically-based pharmacokinetics (PBPK). The processes in the human body include:

- *Absorption*, the rate and amount of an agent that is transported from the environment into the body;
- *Distribution*, the rates and destinations/locations to and from which the agent is moved or deposited, typically by transport in body fluids;
- *Metabolism*, the rates and chemical identities of the products from biochemical transformation of the agent in the body; and
- *Elimination,* the rates and amounts of the agent and/or its biochemical products that are released from the body.

Individually, these processes are referred to as *ADME*, picking up the first alphabetic letter from each. Taken collectively, these processes essentially are synonymous with PBPK.

This logical extension of the term *exposure assessment* to account for all elements of source, fate and transport is not merely an intellectual exercise. We believe that an artificial partitioning of contributions and contributors has taken place. Nearly all of the tools

of environmental[21] "fate and transport" and those of PBPK are shared applications, taken from chemistry, engineering, mathematics and statistics. Moreover, artificially separating the professional practices forfeits a measure cooperation and collaboration that could improve both proficiency and efficiency of the overall risk assessment process.

Research and development in PBPK are enormously promising areas that have not been fully exploited. The final rule should encourage and reward scientific advancement in this area. We have mentioned it here within the definition of *exposure assessment* even though it is typically considered part of toxicology because the skills needed to design and implement PBPK models are more commonly found among the mathematicians and engineers who populate exposure assessment than they are among classically trained toxicologists. The purpose of using [square brackets] is to indicate that it is not essential that it is included here or within dose-response assessment, but it ought to be included at least one place to ensure it is not ignored.[22]

4. Dose-response assessment.

DOL NPRM	Suggested Alternative
Dose-response assessment. The dose response assessment step examines the relationship between exposure to a hazardous substance and an adverse health outcome.	"Dose-response assessment" is the estimation of the relationship between exposure to an agent and the incidence and severity of an adverse health outcome[, taking account of physiologically-based pharmacokinetics].

[21] In this context, "environmental" can be freely substituted with "occupational" or "workplace environmental."

[22] The National Research Council's *Red Book* model for risk assessment was developed at a time when PBPK was truly an infant discipline. It lies in the interstitial space between *exposure assessment* and *dose-response assessment*. We are advocates of the *Red Book* model but caution against a doctrinaire interpretation of it that unwittingly excludes PBPK.

Dose-response assessment is more than merely *examining* the relationship between exposure and outcomes. Dose-response assessment is the *quantitative or semi-quantitative estimation* of that relationship, typically using classical or Bayesian statistical methods.[23] Our suggested alternative language is more explicit about this and would avoid the unnecessary ambiguity in the Department's definition.

We strongly urge you to drop from the definition the adjectives such as "hazardous" (which appears 16 times in the NPRM) and "toxic" (which appears 11 times). These adjectives falsely imply either-or conditions -- that an agent is either "hazardous" or it is not, or it is "toxic" or it is not. Hazard and toxicity are not either-or conditions except under extraordinarily rare circumstances. Except for demonstrated genotoxic carcinogens, an agent is nonhazardous or nontoxic until a threshold is reached, and the nature and degree of hazard or toxicity then rises as exposure increases. Some agents are beneficial to human health at low doses and hazardous or toxic at high doses. A risk assessment of a "toxic substance" indicating that it does not pose a risk at occupational exposures suffers from cognitive dissonance: how is it possible that something which is toxic also is not risky?

In addition, describing an agent as *hazardous* or *toxic* before risk assessment is performed prejudges the outcome of the analysis. The purpose of risk assessment is to estimate risk. Risk assessment is superfluous if scientists or decision-makers have decided in advance that an agent is *hazardous* or *toxic*. This puts the cart before the horse.

[23] The preamble of the NPRM includes text that describes dose-response assessment only with respect to carcinogens. See p. 50911: "Under the Department's current procedures, the quantitative estimation of health risk may involve the use of dose-response mathematical models which extrapolate scientifically observable data in humans or animals to a variety of exposure scenarios."

5. Risk.

DOL NPRM	Suggested Alternative
"Risk" is the probability of the occurrence of harm given exposure to the hazard.	"Risk" is the probability that a specified timing, intensity, frequency, and duration of exposure to a hazard will result in an adverse human health effect.

The Department's definition is reasonable, but it is ambiguous about the specific conditions of exposure to which it is contingent. Clearly specifying these terms and conditions would greatly improve the definition. This additional clarity can be very helpful throughout the risk analysis process – from the estimation of risk to the identification and analysis of regulatory options to the Department's risk communication activities. An important challenge of risk communication is overcoming decades of practice in which the public has been led to believe that risks can be described by single numbers, they are neither variable nor uncertain, and that agents are either "safe" or "unsafe."

Thinking in terms of exposure attributes within the definition of risk also helps motivate another central point we want to make sure to emphasize in these comments: The best estimate of risk will never be a single value, but rather a distribution of values that depend on exposure attributes and other factors. Similarly, the hazard term in the equation also will not be well described by a single value. For any agent, people differ in their sensitivity and susceptibility. This can be captured in distributional terms as well.

6. Risk assessment.

DOL NPRM	Suggested Alternative
"Risk assessment" is defined as the overall process of evaluating the risk associated with a health hazard from a toxic substance or hazardous chemical.	"Occupational health risk assessment" is a systematic approach to organizing and analyzing scientific knowledge and information about hazard, exposure.

We support the Department's decision to follow the guidance set forth decades ago by the National Research Council (1983) to define risk assessment as *process* and not as an output or document. The NRC has updated its language somewhat since then (National Research Council 1994), and our suggested alternative borrows more from that latter text (p. 4). As we noted in our discussion of the definition of *hazard*, we have removed the prejudicial adjectives *toxic* and *hazardous*.

We are well aware that many agencies use *risk assessment* to define specific work products and that this results in confusion.[24] The Department can help reduce this confusion by being very clear in its choice of language as to whether it is referring to the *process* or the *product* of risk assessment.

[24] Confusion between the *process of risk assessment* and *federal agency documents called risk "assessments" that are products of the risk assessment process* was endemic to OMB's proposed risk assessment guidance (Office of Management and Budget 2006) and the National Research Council's review (National Research Council 2007).

7. Risk characterization.

DOL NPRM	Suggested Alternative
Risk characterization. The risk characterization step provides estimates of risk to workers from occupational exposure scenarios of interest. The risk characterization also summarizes the key findings and discusses the limitations of the data, the choice of assumptions, the inherent uncertainties associated with the estimates of risk, limitations of the database, and how these factors impact the risk assessment.	"Risk characterization" combines the assessments of exposure and dose-response under various conditions to estimate the probability of specific adverse health effects to an exposed individual or population, taking into account variability in the exposed population, uncertainty about scientific information that is either known or knowable, and uncertainty about what cannot be known.

The Department's definition begins in the right place -- estimating risks to workers from occupational exposures. However, the definition then strays into a jumble of process issues that concern the presentation of information. These issues should not be addressed within a crucial definition, but instead elucidated separately in a different section dedicated to process matters.

In addition, the preamble also strays into risk management considerations whose scientific premises no longer apply. The *Benzene* case speaks to risk management and it was decided in a milieu of extensive scientific ignorance. At the time, it was infeasible for OSHA to incorporate high-quality scientific information into risk assessment. That is no longer true, and nothing in *Benzene* or the OSH Act requires OSHA to prepare scientifically biased risk assessments.

Our proposed alternative is a modified version of the definition provided by the National Research Council in *Science and Judgment* (1994, p. 5). It focuses on the derivation of estimates of individual and population risk, and leaves the issue of transparency to be resolved by the information quality framework.

8. Consistency and Reliability.

DOL NPRM	Suggested Alternative
[None.]	Delete the principles.

The preamble says *consistency* and *reliability* are "core principles" underlying the NPRM, and it uses these terms three and six times, respectively. However, the Department never defines them. We cannot locate external authorities in risk assessment appropriate for occupational health risk assessment that OSHA could fall back on for help, and we note that neither term is part of the information quality paradigm.

Based on our reading of the preamble, we think the Department is trying to assure that the products of future DOL agency risk assessment are similar to the products of risk assessment processes that that have been conducted in the past, but at the same time follow best practice in the field.[25] These are incompatible goals.[26] Best practices in the field improve over time, and if DOL agencies keep up with best practice it is inevitable that future risk assessments will be very different from the past. Consistency can only be achieved by freezing the risk assessment methods that DOL agencies use, something that we regard as highly undesirable.

[25] See p. 50910: "The approaches used to assess risk should conform to accepted scientific practice and strive to be consistent with approaches used in previous occupational standards that address similar hazards and agents." We cannot discern what purpose the Department intends to accomplish by making *reliability* a "core principle" unless it is as a synonym for the information quality principle of *substantive objectivity.* If that was the Department's intent, it is already addressed in proposed §2.9(c)(5).

[26] At the same time that the Department says it wants to achieve consistency with past practice, it also notes that the Commission on Risk Assessment and Risk Management said, "OSHA seems to have relied upon a case-by-case approach for performing risk assessment and risk characterization" (p. 50910). Whatever the merits of a case-by-case approach, the Department cannot simultaneously say that it is deficient and say that future risk assessments should be consistent with it.

PRINCIPLES FOR INFORMATION QUALITY

The NPRM establishes that the purposes of this rulemaking are to provide an authoritative reference standard for DOL agency occupational health risk assessments and ensure that these risk assessments adhere to the Department's Information Quality Guidelines (U.S. Department of Labor 2002). These guidelines have been in force for nearly six years and apply to all covered information disseminated by the Department and its various agencies. However, considerable confusion remains concerning how the Department's Information Quality Guidelines apply to risk assessment. The text of the rule clearly establishes the link between information quality and risk assessment (p. 50915, § 2.9(c)(5)), but it does not add additional clarity concerning *how* to apply the guidelines in practice.[27]

The Department should remove the redundant elements in this section of the preamble and provide more explicit direction to DOL agencies concerning *how* to apply the Department's Information Quality Guidelines to risk assessment. As we indicated earlier, we strongly favor a performance-standards approach consistent with what scholars of regulation have recommended, specifying what needs to be achieved but provides wide latitude for scientific advancement and innovation in how to achieve it. With that in mind, we offer several suggestions for how the Department could add clarity and assure that the risk assessment process incentivizes scientific advancement and technical innovation.

1. **Risk assessments must be fully transparent with respect to all assumptions, data, and models.**

Transparency is the most important procedural requirement of the information quality paradigm (U.S. Department of Labor 2002), and it is commonly lacking from government risk assessment documents. As scientists and educators, we have always insisted that our students "show their work." This is the essential procedural

[27] Much of the information quality content in the preamble is devoted to language from the Safe Drinking Water Act. This is superfluous. The Department has already "adopted or adapted" that language, in accordance with OMB's 2002 directive, into its Information Quality Guidelines (U.S. Department of Labor 2002, Appendix II).

element of the Department's Information Quality Guidelines, and this rule would be an excellent place to reiterate the Department's commitment to the principle.

A common problem in health risk assessment is that the refereed research articles typically used as inputs do not disclose all relevant information. This is an inherent feature of the research and publication process, which places a high value on parsimony and brevity in exposition. It is not unusual for the results of a multimillion-dollar multi-year research project to be synthesized into just a handful of pages in a scientific journal. There is nothing wrong with this format when the objective is communication among scholars, but it is seriously deficient when terse research articles are used as the foundation for risk assessment. The format of scientific and scholarly publication is incompatible with transparency.

We encourage the Department to include within its final rule provisions that encourage the full disclosure of data and models by researchers whose work is important for risk assessment. Researchers should be willing to practice full disclosure if they want the results of their work to influence public policy.[28]

2. Risk assessments must be capable of being reproduced by qualified third parties under the constraints that apply to public review.

Reproducibility means the ability to use the agency's data and methods and get essentially the same results (U.S. Department of Labor 2002). It is not the same as *replicability*, which means the ability to repeat an experiment or study.[29] Results that have not been

[28] The *American Economic Review*, the flagship scholarly journal of the American Economic Association, has established a requirement that authors make their data and models available. See http://www.aeaweb.org/aer/data_availability_policy.html. Unfortunately, this practice is unusual among the biomedical journals in which scientific papers used in risk assessment are published.

[29] See U.S. Department of Labor (U.S. Department of Labor 2002, p. 13): "It is understood that reproducibility of data is an indication of transparency about research design and methods and thus a replication exercise (i.e., a new experiment, test, or sample) shall not be required prior to each dissemination."

replicated ought to be treated as exploratory or provisional except in the rare circumstance where replication is technically infeasible. To ensure that this can be done, risk assessments must be accompanied by all data and models, and sufficient documentation of both, to enable qualified third parties to reproduce the agency's results.

Reproducibility is the first stage of a rigorous, information quality-based peer review. This is severely impeded when risk assessors rely on proprietary data or models, or in the case of agency risk assessments, the amount of time allowed for peer review is unreasonably short.[30]

3. Risk assessments must provide substantively and presentationally objective portrayals of both the latest scientific knowledge and the state of scientific uncertainty.

Substantive objectivity is the cornerstone of the information quality paradigm (U.S. Department of Labor 2002). For risk assessments to meet this standard, they must be as free as possible of embedded risk management preferences. The principles of *consistency* and *reliability* are not substitutes for objectivity, but they can be useful insofar as they are understood to mean that objectivity should be achieved *consistently* and *reliably*.

This principle is fully compatible with the laws the Department is charged with implementing. The OSH Act and Mine Act delegate to the administrators of OSHA and MSHA the authority to make risk management decisions. Agency staff should not exercise that authority. By the same token, agency officials have no business directing agency risk assessors to embed their policy preferences into DOL agency risk assessments. Maintaining a clear distinction between science and policy is an enduring prescription from the 1983 National Academy's *Red Book* but one that seems to have been consistently misunderstood and misapplied (North 2003).

[30] A 30-day public comment period on a risk assessment is unreasonable in all cases. For complex risk assessments, 90 days may not be enough.

4. Risk assessments must prefer scientific information that has been independently replicated or confirmed, except in extraordinary circumstances, must refrain from using information that has not been replicated or confirmed.

In the NPRM, the Department states a commitment to use "best available scientific methodologies, information and health and exposure data when conducting the analyses for each of the four steps in the risk assessment paradigm" (p. 50911). However, the Department never gives an operational definition of "best," nor or that matter does the Department rank the quality of scientific information. This ambiguity will only postpone, rather than prevent, conflict over the science used in DOL agency risk assessments.

Except in rare circumstances, research results generally need to be replicated, often more than once, before they gain status as "accepted" science. For this reason, we recommend that the Department establish a quality hierarchy for scientific information along the following lines:

- Quality 1: Scientific information that has not been independently replicated or confirmed.
- Quality 2: Scientific information that has been independently replicated or confirmed.

Quality 1-level information must be interpreted as exploratory and may be used for generating hypotheses, but it cannot be used to draw inferences about risk. Quality 2-level information may be used for drawing inferences about risk. The Department could include an exception for scientific information or results for which replication is technically infeasible, but this exception should be invoked very rarely.

5. Scientific information derived from surveys must adhere to applicable federal standards and guidelines.

The federal government has long had informal standards for statistical information derived from surveys, and these standards were recently codified after an interagency process in which the Department actively participated (Office of Management and Budget 2006). DOL agency risk assessments that rely on survey-based information must ensure that the information they use adheres to these standards.

PRINCIPLES FOR RISK ASSESSMENT

Despite the number of separable steps and elements in the risk assessment process, there are important principles that apply throughout. We address these principles in this section, and discuss principles for hazard assessment, exposure assessment, and risk characterization in subsequent sections.

1. Screening-level risk assessments must be used only for setting priorities and deciding not to take action.

Given the wide variety and large number of potential agents that DOL agencies must deal with, it is necessary to set priorities. A reasonable way to set priorities scientifically is to perform screening-level analyses of various agents. Screening-level analyses use worst- or near-worst case assumptions to determine the consequences that would arise *if* these assumptions were true. For any agent in which these consequences do not rise to the agency's statutorily-defined level of concern – "significant risk," in the case of OSHA – no further risk assessment effort is warranted. As a risk communication matter, the message DL agencies should disseminate is simple: even under worst-case conditions, this agent does not pose an occupational health concern. An objectively performed and explained screening-level risk assessment *never assumes* that these worst-case assumptions are true.

Moreover, it is wrong to use language suggesting that an agent whose worst-case risk estimate exceeds this threshold poses an occupational risk. Screening-level risk assessments are not designed to answer that question. For that reason, it is crucial that the results of screening-level risk assessments be accompanied by thorough and effective disclaimers to deter public misunderstanding.

2. Safety assessment is not risk assessment.

Certain procedures are widely used to derive safety thresholds. Examples include the Reference Dose/Concentration (RfD/RFC) methods used by the Environmental Protection Agency (EPA) and the Allowable Daily Intake (ADI) method used by the Food and Drug Administration (FDA). The purpose of these methods is to establish risk-informed thresholds that give a practical meaning to the term *safety*. It is crucial to understand, however, that whether an agent is

"safe" cannot be determined by the application of scientific methods and tools. Whether something is "safe" is a strictly subjective, nonreproducible, and scientifically untestable determination.

These methods have a long history that precedes the development of modern risk assessment. In the 1940s, a procedure was created system established by Arnold Lehman and colleagues to help the Food and Drug Administration decide whether exposure to an agent was "safe" (Lehman and Laug 1949). These methods have evolved considerably over the years, but they continue to have in common procedures for obtaining an order-of-magnitude estimate of the dose believed to be without risk.

The purpose of safety assessment is to determine what is *safe* or what is an *acceptable risk* – that is, make a risk management *policy judgment*. But the purpose of risk assessment is to estimate risk – that is, make a *scientific* statement that, although inherently uncertain, is intended to *de*scribe the world and not *pre*scribe what it ought to look like. Safety assessments provide subjective estimates of thresholds below which exposure is not believed to pose any concern. These thresholds say nothing about whether *higher* exposures pose any risk, however. They are not designed to answer that question. Because they are subjective, nonreproducible, and untestable using scientific methods, safety assessment methods are not compatible with the Information Quality Act (IQA) and its implementing guidance when they are represented as he products risk assessment.[31]

[31] Leaving aside risk management judgment that is implied by safety assessment, to be *substantively objective* a risk estimate for (say) the 99th percentile of a subpopulation must be a "accurate, reliable, and unbiased" estimate of that quantity (U.S. Department of Labor 2002, p. 12). It cannot be used as a representation of the median (50th percentile) because such a representation would be inherently inaccurate. It also cannot be used as a representation of the mean except in the special case where the mean and 99th percentile happen to be the same. To be *presentationally objective*, a substantively objective 99th percentile risk estimate must be accompanied by the 1st percentile and a central tendency estimate (p. 16). The procedures used to generate safety assessment thresholds are not designed to provide this information.

3. Default assumptions and values must be used only as a last resort, when neither data nor models are available to provide an objective basis for estimating risk.

An unintended consequence of the National Research Council's 1983 *Red Book* model is that risk assessors have tended to use default assumptions and values as barriers to the use of data and models (North 2003). At the time the committee deliberated this issue, the scope of scientific ignorance seemed boundless. In the past 25 years, however, scientific knowledge has grown considerably in understanding the mechanisms underlying many diseases and their relationship to exposure to specific agents. But, conventional practice in risk assessment has not kept pace with these developments because it is much easier to rely on defaults than to use new data and develop models that explain newly understood but complex mechanisms.

The Department should use this opportunity to make a clear break from the past in this regard.

4. As long as they contribute greater value to risk assessment than they cost to obtain, data are preferred to assumptions.

The Department should establish as a fundamental principle for occupational health risk assessment that it is nearly always better to have and use data than to rely in assumptions. We readily acknowledge that some data are too hard, expensive, or perhaps invasive to collect, and we are not recommending that DOL agencies be required to throw out every assumption used in lieu of data. We are recommending, however, that whenever the social cost of obtaining data is less than their value for improving the accuracy or precision of risk assessment, DOL agencies should be expected to obtain them.[32]

5. Validated data and models are always preferred to non-validated data and models.

[32] The question of whether DOL agencies or regulated parties should pay the cost of obtaining such data is a secondary matter that can be resolved. In our experience, regulated parties are willing to provide data so long as they are assured that their social value for risk assessment exceeds the cost of acquisition.

Validated data and models are higher in quality than unvalidated data and models. Both EPA and the Food and Drug Administration have rigorous good laboratory procedures (GLPs) that apply to regulated parties that generate certain primary data for regulatory purposes. Other organizations have similarly rigorous internal standards. Data that have been obtained through such procedures must be given preference.

6. **Except under extraordinary circumstances, publicly available data and models shall be preferred to proprietary data and models. If proprietary data or models are used, DOL agency risk assessments must include provisions for especially rigorous external and independent peer review conducted with the minimum confidentiality protections needed to protect the intellectual property of the data or model owner. Federally-funded information shall not be eligible for proprietary status.**

The Department's information quality guidelines implicitly discourage the use of proprietary data and models by imposing potentially burdensome peer review requirements (U.S. Department of Labor 2002, pp. 4 and 13). Sometimes, there is no alternative to proprietary data or models. However, we believe that this is an exceedingly rare event in occupational health risk assessment.

The most likely scenario in which a proprietary data or model claim might be made is one in which a researcher does not want to give up the value of intellectual property contained in a database or computer program, We understand the importance of protecting intellectual property, and we do not believe that the government should expropriate that value by attempting to compel public disclosure.

In the case where regulated entities have created the data, it is understood that they must sacrifice any intellectual property rights in order for the government to use it. That is often not the case for data generated as the result of a government-funded university-based research program. Such data are routinely withheld from the public.

The Department should treat federally-funded owners of proprietary data and models the same as it treats regulated-entity owners.[33]

7. Data and models obtained for one purpose must not be used for a different purpose unless it is shown that their use for the different purpose is scientifically and statistically justified.

A common phenomenon in our experience is that agencies will perform or sponsor research for a low-intensity purpose (e.g., testing of an analytic methodology, exploratory data analysis) but subsequently use it for a high-intensity purpose (e.g., risk assessment). This practice should be discouraged because the research protocols that were used to support the low-intensity data collection often were insufficiently rigorous to support the high-intensity purpose. Examples of protocol deficiencies may include such things as sample representativeness, nonresponse bias, and QA/QC procedures.[34]

Before a DOL agency is permitted to use information collected for a less intense purpose, it must be required to show that the data satisfy the information quality and scientific demands of the more intense purpose.

8. Hazard, exposure and risk distributions are always preferred to point estimates and ranges, and these distributions must be incorporated into sensitivity analyses that show how risk estimates depend on the most influential assumptions, data and models utilized.

---

[33] Federal law permits agencies to obtain data that are generated as the result of federal research programs (Office of Management and Budget 1999). The Department should expect to exercise these rights when DOL agencies intend to use government-funded data as the foundation for risk assessment.

[34] When OMB reviews Information Collection Requests pursuant to its statutory authority under the Paperwork Reduction Act, it takes at face value the practical utility claims given by the submitted agency. If an agency states that the information it seeks will not be used for regulatory purposes, OMB's review is correspondingly less rigorous.

The use of point estimates to describe risk distributions is a long-standing ancient practice that the Department should actively discourage. Risk assessment tools exist for capturing uncertainty and (especially) variability, and the DOL agencies should be directed to routinely use these tools.[35]

In practice, we have personally observed numerous instances in which an agency risk assessment included uncertainty analysis but for some reason examined only the least interesting sources of variability and uncertainty. It is for that reason that we advise the Department to explicitly direct DOL agencies to perform sensitivity analysis on the "most influential" assumptions, data and models.

9. When results are extrapolated from one subpopulation to another, or to the population as a whole, differences between the two groups must be fully and quantitatively accounted for.

It is a commonplace occurrence to have good data for one subpopulation but not for the subpopulation covered by the risk assessment.[36] Or, the data available apply to the correct subpopulation but not to a representative sample.[37] These differences must not be ignored just because they are hard to account for.

[35] The National Research Council (2007, p. 31) calls these "Level 1 uncertainty [analysis] methods that are accepted and standardized. These are methods and techniques about which there is near unanimity in the scientific community. The subjective, or Bayesian, interpretation of probability for representing uncertainty would be in this category, as would Monte Carlo methods of propagation, including Latin hypercube sampling, stratified sampling, and pseudo-random-number sampling. Standard statistical techniques for quantifying the uncertainty associated with estimates of model parameters also belong here."

[36] For example, data may be available for males but not females, but there may be a sound scientific basis for believing that risks to females are different, whether for reasons of biology or exposure.

[37] For example, data obtained from an enforcement action are likely to be unrepresentative.

10. Peer review must be rigorous, external, independent, and explicitly address information quality principles and adherence to information quality guidelines.

The conventional peer review model adds a great deal of benefit to improving the scientific quality of risk assessment. However, there are important limitations to the government peer review process. For example, agencies often prefer to restrict reviewers to only a subset of the important scientific issues, or they may select reviewers based on criteria other than scientific competence. OMB has issued government-wide guidance on peer review (Office of Management and Budget 2005), and the Department now publishes an online list of which information products are subject to peer review and what kind of peer review is underway or planned.[38] We cannot tell from reviewing this limited information whether the Department's peer review program actually provides the value-added that OMB's guidelines were intended to create. Reiterating the Department's commitment to peer review in the final rule would be a welcome step toward providing this assurance.

In addition, there is no indication from these references that DOL agency peer reviews include the review of information quality principles or any assessment of whether the Department's Information Quality Guidelines were followed. Our review of the peer review procedures of other agencies suggests that this generally is not occurring.[39] The Department should take this opportunity to make information quality an explicit part of its peer review program.

CONCLUSION

We are pleased to have been able to provide these comments to the Department to help make constructive improvements in the text. There are many places the Department can look for external authority

[38] See *Department of Labor Peer Review Agenda*, evergreen at http://www.dol.gov/asp/peer-review/.

[39] EPA has incorporated information quality into its Peer Review Handbook (U.S. Environmental Protection Agency 2006), but we have yet to see any instance in which an EPA-sponsored peer review actually addresses information quality principles or adherence to EPA's Information Quality Guidelines (U.S. Department of Labor 2002).

in risk assessment. Where we have been able to provide a foundational reference for a recommendation, we have tried to include it.

For information quality, only a few references exist. The problem the Department faces is that applicable information quality guidelines do not contain enough guidance on how to apply information quality principles to risk assessment. We hope that our exposition here helps fill that gap.

Sincerely,

Richard B. Belzer, PhD[40]

Steven C. Lewis, PhD, DABT

REFERENCES

Breyer S. 1982. Regulation and Its Reform. Cambridge, Mass.: Harvard University Press.

Lehman AJ, Laug EP. 1949. Procedures for the Appraisal of the Toxicity of Chemicals in Foods. *Food, Drug, and Cosmetic Law Quarterly* 3: 412-434.

National Research Council. 1983. Risk Assessment in the Federal Government: Managing the Process. Washington, D.C.: National Academies Press.

National Research Council. 1994. Science and Judgment in Risk Assessment. Washington, D.C.: National Academies Press.

[40] Corresponding author: Belzer@regulatorycheckbook.org.

National Research Council. 2007. Scientific Review of the Proposed Risk Assessment Bulletin from the Office of Management and Budget. Washington, DC: National Academies Press.

North DW. 2003. Reflections on the Red/Mis-Read Book, 20 Years After. *Journal of Human and Ecological Risk Assessment* 9(5).

Office of Management and Budget. 1999. *Circular A-110: Uniform Administrative Requirements for Grants and Agreements With Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations*. "OMB Circular A-110". Washington, D.C.

Office of Management and Budget. 2005. Final Information Quality Bulletin for Peer Review. *Federal Register* 70(10): 2664-2667.

U.S. Department of Labor. 2002. *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Department of Labor*. "DOL IQG". Washington, D.C.: U.S. Department of Labor.

U.S. Department of Labor. 2008. *Requirements for DOL Agencies' Assessment of Occupational Health Risks; Review Draft Notice of Proposed Rulemaking*. "DOL Risk Assessment Draft NPRM".

U.S. Environmental Protection Agency. 2006. *Peer Review Handbook*. "EPA Peer Review Handbook 3rd Ed". Washington, D.C.: U.S. Environmental Protection Agency Science Policy Council.

Viscusi WK, Vernon JM, Harrington Jr. JE. 1997. Economics of Regulation and Antitrust. 2nd ed. Cambridge, Mass.: MIT Press.

White LJ. 1981. Reforming Regulation: Processes and Problems. Englewood Cliffs, N.J.: Prentice-Hall.